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"IP mobility mechanism for a packet radio network"
(IP-liikkuvuusmekanismi pakettiradioverkkoa varten)

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IP mobility mechanism for a packet radio network

Background of the invention

The invention relates to a mechanism for providing IP (Internet Protocol) mobility in a packet radio network such as GPRS or UMTS. IP mobility is the topic of standard RFC2002 by the Internet Engineering Task Force (IETF). This RFC standard is incorporated herein by reference. In short, IP mobility is a mechanism for providing a mobile user with telecommunications capability using an IP address. It enables mobile nodes to change their points of attachment in the Internet without changing their IP address. Thus it facilitates the communication of a mobile node and a correspondent node with the mobile node's home address. Fig. 1 illustrates the concept of an IP mobility mechanism in a packet radio network.

Within the context of this application 'Network Access Server (NAS)' is a device providing users with temporary, on-demand network access. This access is point-to-point using telephone, ISDN or cellular connections, etc. 'Mobile Node (MN)' refers to a host that wishes to use a Home Network address while physically connected by a point-to-point link (phone line, ISDN, etc.) to a NAS that does not reside on the Home Network. 'Correspondent node' is a peer node with which a mobile node is communicating. The correspondent node may be either mobile or stationary. 'Mobile Station (MS)' is a mobile node having a radio interface to the network. A 'Tunnel' is the path followed by a datagram when it is encapsulated. The model is that, while it is encapsulated, a datagram is routed to a known decapsulation agent, which decapsulates the datagram and then correctly delivers it to its ultimate destination. Each mobile node connecting to a home agent does so over a unique tunnel, identified by a tunnel identifier which is unique to a given Foreign Agent/Home Agent pair.

The MS can be a laptop computer PC connected to a packet radio enabled cellular telephone. Alternatively, the MS can be an integrated combination of a small computer and a packet radio telephone, similar in appearance to the Nokia Communicator 9000 series. Yet further embodiments of the MS are various pagers, remote-control, surveillance and/or data-acquisition devices, etc.

The Radio Access Network RAN can be a part of a GPRS system or a third generation (3G) system, such as UMTS. The RAN comprises an air interface Um which is a performance bottleneck. SGSN and GGSN are GPRS

terms for access and gateway support nodes, respectively. In so-called third generation (3G) systems, the SGSN nodes are sometimes referred to as 3G-SGSN nodes. Subscriber information is stored permanently in the Home Location Register HLR.

'Home Network' is the address space of the network to which a user logically belongs. When a workstation is physically connected to a LAN, the LAN address space is the user's home network. 'Home Address' is an address that is assigned to a mobile node for an extended period of time. It may remain unchanged regardless of where the MN is attached to the Internet. Alternatively, it could be assigned from a pool of addresses. 'Home Agent' is a routing entity on a mobile node's home network which tunnels packets for delivery to the mobile node when it is away from home, and maintains current location information for the mobile node. It tunnels datagrams for delivery to, and detunnels datagrams from, a mobile node when the mobile node is away from home.

'Foreign Agent' refers to a routing entity on a mobile node's visited network which provides routing services to the mobile node while registered, thus allowing a mobile node to utilise its home network address. The foreign agent detunnels and delivers packets to the mobile node that were tunnelled by the mobile node's home agent. For datagrams sent by a mobile node, the foreign agent may serve as a default router for registered mobile nodes.

RFC2002 defines 'Care-of Address' (COA) as the termination point of a tunnel toward a mobile node, for datagrams forwarded to the mobile node while it is away from home. The protocol can use two different types of care-of address: a "foreign agent care-of address" is an address of a foreign agent with which the mobile node is registered, and a "co-located care-of address" is an externally obtained local address which the mobile node has associated with one of its own network interfaces. Within the context of this application, 'Care-of Address' (COA) is an address of a foreign agent with which the mobile node is registered. An MN may have several COAs at the same time. A primary COA is the address which the MN sends to its HA when registering. The list of COAs is updated when advertisements are received by the mobile node. If an advertisement expires, its entry or entries should be deleted from the list. One foreign agent can provide more than one COA in its advertisements. 'Mobility Binding' is the association of a Home Address with a Foreign Agent IP address and a Tunnel ID. An MN registers its COA with its HA by

sending a Registration Request. The HA replies with a Registration Reply and retains a binding for the MN.

In basic versions of mobile IP, all datagrams destined to an MN are routed via the MN's home network and home agent HA. This process is called triangle routing. It may increase the load of the network and the HA may be a performance bottleneck. So-called route optimisation protocol extensions for mobile IP aim to eliminate the problems associated with triangle routing. In route optimisation, correspondent nodes and previous FAs may retain an up-to-date binding for the MN in their binding caches. As a result, the correspondent nodes may tunnel their datagrams directly to the MN's COA and previous FAs may forwards datagrams destined to the MN to the MN's current COA. The binding may be retained after reception of a Binding Update. If requested, a node should acknowledge the reception by sending a Binding Acknowledge. These messages must be authenticated. They are typically carried by User Datagram Protocol (UDP).

Routing data packets to an MN is a problem in a packet radio network, such as GPRS. This is because the MN's data network address typically has a static routing mechanism, whereas a MN can roam from one subnetwork to another. One approach for data packet routing in a mobile environment is the concept of mobile IP. Mobile IP enables the routing of IP datagrams to mobile hosts, independent point of attachment in the subnetwork.

The standard mobile IP concept does not fit exactly in the GPRS environment because network protocols other than IP must be supported too. GPRS infrastructure comprises support nodes such as a GPRS gateway support node (GGSN) and a GPRS serving support node (SGSN). The main functions of the GGSN nodes involve interaction with the external data network. The GGSN updates the location directory using routing information supplied by the SGSNs about an MS's path and routes the external data network protocol packet encapsulated over the GPRS backbone to the SGSN currently serving the MS. It also decapsulates and forwards external data network packets to the appropriate data network and handles the billing of data traffic.

The main functions of the SGSN are to detect new GPRS mobile stations in its service area, handle the process of registering the new MSs along with the GPRS registers, send/receive data packets to/from the GPRS MS, and keep a record of the location of the MSs inside of its service area.

The subscription information is stored in a GPRS register where the mapping between a mobile's identity (such as MS-ISDN or IMSI) and the PSPDN address is stored. The HLR acts as a database from which the SGSNs can ask whether a new MS in its area is allowed to join the GPRS network.

The GPRS gateway support nodes GGSN connect an operator's GPRS network to external systems, such as other operators' GPRS systems, data networks 11, such as an IP network (Internet) or a X.25 network, and service centres. Fixed hosts 14 can be connected to data network 11 e.g. by means of a local area network LAN and a router 15. A border gateway BG provides an access to an inter-operator GPRS backbone network 12. The GGSN may also be connected directly to a private corporate network or a host. The GGSN includes GPRS subscribers' PDP addresses and routing information, i.e. SGSN addresses. Routing information is used for tunnelling protocol data units PDU from data network 11 to the current switching point of the MS, i.e. to the serving SGSN. The functionalities of the SGSN and GGSN can be connected to the same physical node.

The home location register HLR of the GSM network contains GPRS subscriber data and routing information and it maps the subscriber's IMSI into one or more pairs of the PDP type and PDP address. The HLR also maps each PDP type and PDP address pair into a GGSN node. The SGSN has a Gr interface to the HLR (a direct signalling connection or via an internal backbone network 13). The HLR of a roaming MS and its serving SGSN may be in different mobile communication networks.

The intra-operator backbone network 13, which interconnects an operator's SGSN and GGSN equipment can be implemented, for example, by means of a local network, such as an IP network. It should be noted that an operator's GPRS network can also be implemented without the intra-operator backbone network, e.g. by providing all features in one computer.

A GPRS network in its current form is able to support IP mobility if a MS implements the mobile IP protocol and if it has a private IP address assigned by some company or Internet service provider (ISP). When a GGSN node assigns a temporary IP address to the MS, the MS can use this temporary address as its care-of-address (COA) and register the address with its home agent, thus benefiting from the mobile IP services. This is also true when the MS is using a predefined GGSN IP address, which can also be regarded as a COA. The only entity that can prevent the MS from using the

Claims

1. A method for providing Internet Protocol-type, or IP-type, mobility for a mobile station (MS) in packet radio network comprising:

at least one support node (GGSN, SGSN);

at least one support node being a gateway support node (GGSN) for interfacing with external networks (11), said gateway node supporting at least an IP-type protocol;

characterized by

integrating, into said at least one gateway support node (GGSN), a home agent (HA) for routing data packets to/from said mobile station;

supplementing said IP-type protocol with an extension for mobility management of said mobile station.

2. A method according to claim 1, characterized in that said gateway node comprises a protocol stack (18, 20) for supporting at least a layer 1 (L1) protocol, a layer 2 (L2) protocol, and a network layer (L3) protocol, and that said IP-type protocol resides on said network layer (L3); and said extension for mobility management is substantially a Mobile IP protocol.

3. A method according to claim 1 or 2, characterized by routing IP data packets to/from said integrated home agent/gateway node (GGSN+HA) using only the network layer (L3) protocol and the layer 2 and layer 1 protocols.

4. A method according to any one of claims 1 to 3, characterized in that the packet radio network comprises a foreign agent (FA) and a serving support node (SGSN), known per se, for supporting mobility management of the mobile station (MS); and that the foreign agent (FA) is integrated into at least one support node (SGSN, GGSN).

5. A method according to claim 4, characterized by integrating the foreign agent (FA) into at least one serving support node (SGSN).

6. A method according to claim 4, characterized by integrating the foreign agent (FA) into at least one gateway support node (GGSN).

7. A packet radio network for providing mobility service to a mobile station (MS), the packet radio network comprising at least one support node

(GGSN, SGSN) wherein at least one support node is a gateway support node (GGSN) for interfacing with external networks (11), said gateway node supporting at least IP-type protocol;

the packet radio network being characterized by an integrated network element (GGSN+HA) comprising the functions of the gateway support node (GGSN) and a home agent (HA) for routing data packets to/from the mobile station;

wherein said IP-type protocol comprises or is associated with an extension for mobility management of said mobile station.

8. A packet radio network according to claim 7, characterized in that the packet radio network comprises a foreign agent (FA) and a serving support node (GGSN), known per se, for supporting mobility management of the mobile station (MS); and that

the foreign agent (FA) is integrated into at least one support node (SGSN, GGSN).

9. A packet radio network according to claim 7 or 8, characterized in that the foreign agent (FA) is integrated into at least one serving support node (SGSN).

10. A gateway support node (GGSN+HA) for a packet radio network, arranged to provide mobility service for a mobile station (MS), wherein the gateway support node (GGSN+HA):

is interoperable with at least one serving support node (SGSN), for routing data packets to/from the mobile station (MS);

supports at least IP-type protocol;

the gateway support node being characterized by comprising the functions of the gateway support node (GGSN) and a home agent (HA) for routing data packets to/from the mobile station;

wherein said IP-type protocol comprises or is associated with an extension for mobility management of said mobile station.

11. Use of a gateway support node (GGSN) as a home agent (HA) for providing mobility service for a mobile station (MS) in a packet radio network, wherein the gateway support node supports at least an IP-type protocol, and said IP-type protocol comprises or is associated with an extension for mobility management of said mobile station.

(57) Abstract

A gateway support node (GGSN+HA) for a packet radio network, arranged to provide Internet Protocol, or IP, mobility for a mobile station (MS). The gateway support node (GGSN+HA) is interoperable with at least one home agent (HA) and at least one serving support node (SGSN), for routing data packets to/from the mobile station (MS). It comprises a protocol stack (18, 20) for supporting at least a layer 1 (L1) protocol, a layer 2 (L2) protocol, and a network layer (L3) protocol, the network layer (L3) protocol supporting at least IP protocol. It also comprises the functions of the home agent (HA) and it is arranged to support Mobile IP protocol on the network layer (L3). Preferably, the protocol stack (20) is streamlined by routing data packets to/from the integrated home agent/gateway node (GGSN+HA) using only the network layer (L3) protocol and the layer 2 and layer 1 protocols.

(Figs. 1 and 2)

Fig. 1

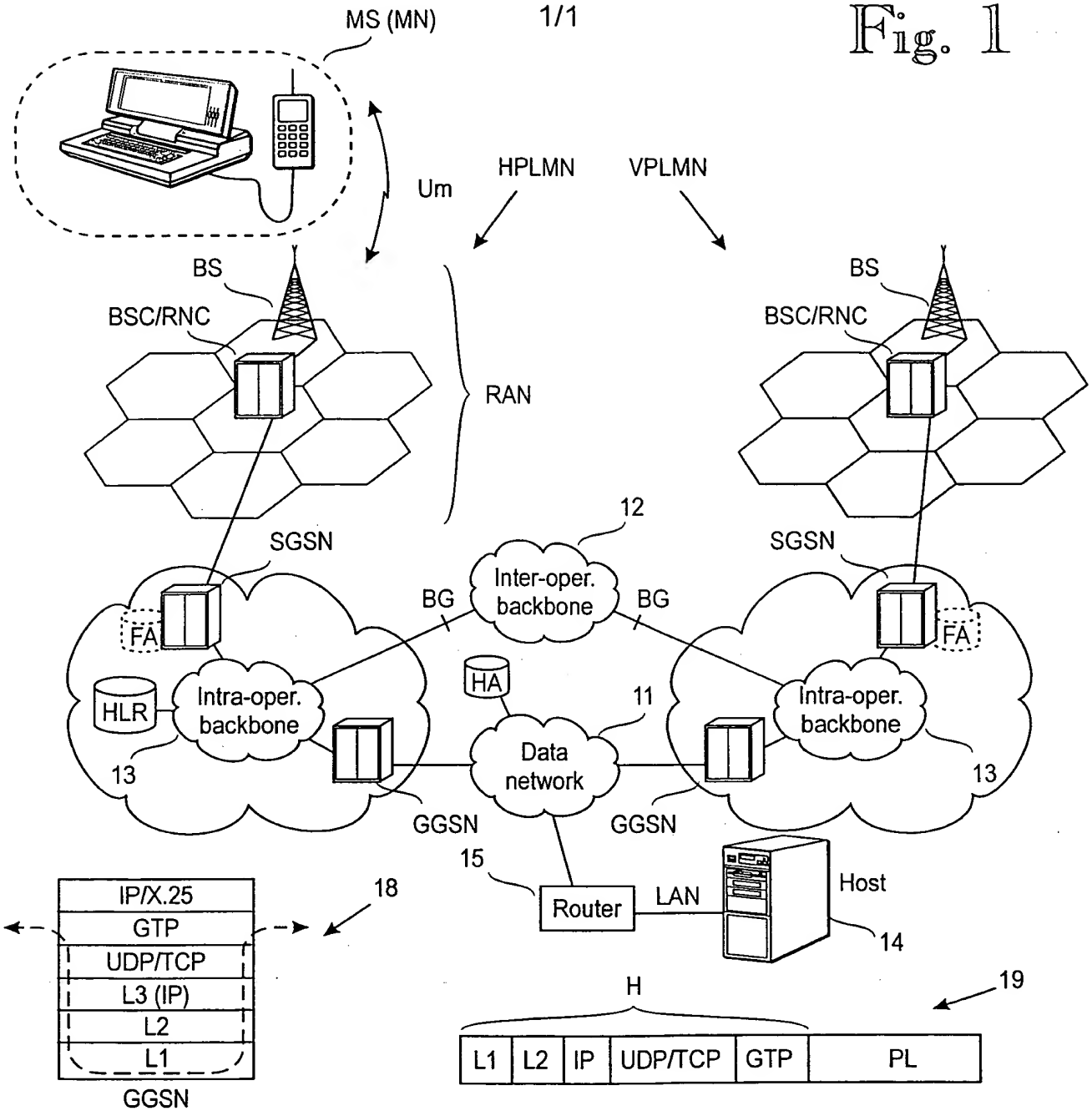
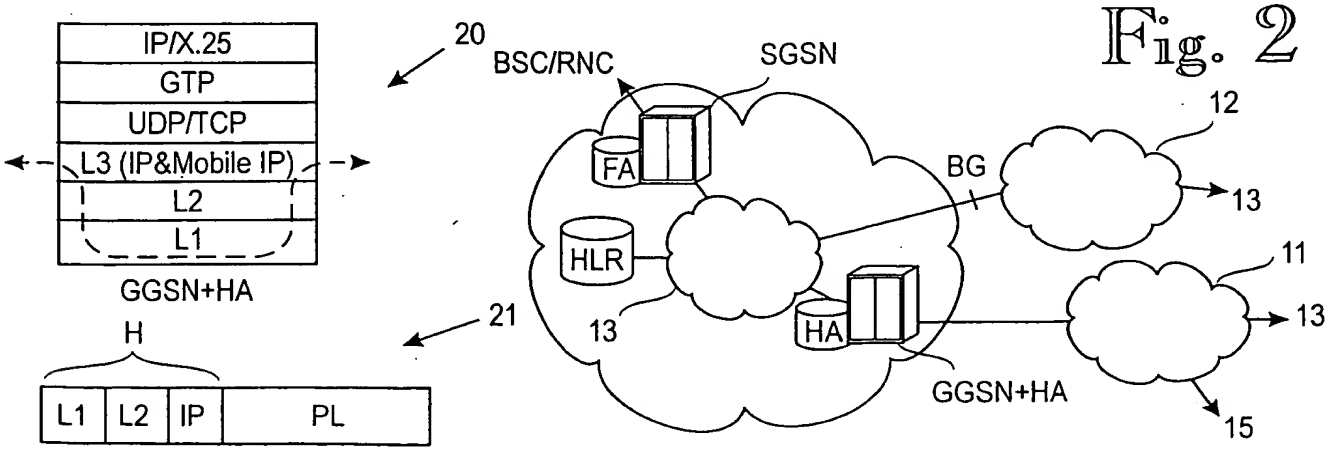

MS (MN)
Um
HPLMN
VPLMN
BS
BSC/RNC
RAN
SGSN
12
Inter-oper. backbone
BG
FA
HA
HLR
Intra-oper. backbone
11
Data network
13
GGSN
15
Router
LAN
Host
14
IP/X.25
GTP
UDP/TCP
L3 (IP)
L2
L1
18
GGSN
H
19
L1
L2
IP
UDP/TCP
GTP
PL

Fig. 2


IP/X.25
GTP
UDP/TCP
L3 (IP&Mobile IP)
L2
L1
20
GGSN+HA
H
21
L1
L2
IP
PL
BSC/RNC
SGSN
FA
HLR
HA
BG
12
13
11
15
GGSN+HA